DOCUMENT RESUME

ED 371 678 HE 027 520

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TITLE Cognitive Effects of Two-Year and Four-Year Colleges: Some New Evidence.
INSTITUTION Illinois Univ., Chicago.; National Center on Postsecondary Teaching, Learning, and Assessment, University Park, PA.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE [94]
CONTRACT R117G10037
NOTE 31p.; For a related report, see ED 357 707.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; Cognitive Development; *Cognitive Measurement; Cognitive Tests; *College Freshmen; Comparative Analysis; *Higher Education; Intellectual Development; Minority Groups; Outcomes of Education; Racial Differences; Sex Differences; Student Development; *Two Year Colleges; Whites

ABSTRACT

This study investigated the relative freshman-year cognitive impacts of five two-year and six four-year colleges and universities drawn from all sections of the United States. The overall sample was 2,685 freshmen students participating in a national longitudinal study and of these the final sample contained 811 students, 280 attending five two-year colleges and 531 attending six four-year colleges. The study design was a pretest-posttest quasi-experimental one in which comparison groups were statistically equated on salient precollege and other variables. Controlling for ability, gender, ethnicity, socioeconomic origins, academic motivation, age, credit hours taken, place of residence, work responsibilities, and the average abilities of the students attending each institution, there was a general parity between two-year college students and their four-year college counterparts on reading comprehension, mathematics, critical thinking and composite achievement. This general parity masked conditional effects based on gender and ethnicity. Men appeared to benefit more from the two-year college experience while women realized greater cognitive returns from four-year colleges. Non-white students benefitted more from attendance at two-year colleges while the reverse was true for their white counterparts. (Contains 37 references.) (JB)

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COGNITIVE EFFECTS OF TWO-YEAR AND FOUR-YEAR COLLEGES: SOME NEW EVIDENCE*

ED 371 678

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*This investigation was conducted as part of the National Study of Student Learning (NSSL) at the University of Illinois at Chicago. NSSL is supported by Grant No.: R117G10037 from the U.S. Department of Education to the National Center on Postsecondary Teaching, Learning, and Assessment.

PROJECT R117G10037
CFDA 84.117G

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Abstract

This study investigated the relative freshman-year cognitive impacts of five two-year and six four-year colleges and universities drawn from all sections of the United States. Controlling for individual precollege ability, gender, ethnicity, socioeconomic origins, academic motivation, age, credit hours taken, place of residence, work responsibilities, and the average precollege ability of the students attending each institution, there was a general parity between two-year college students and their four-year college counterparts on standardized measures of end-of-freshman year reading comprehension, mathematics, critical thinking, and composite achievement. This general cognitive parity, however, masked conditional effects based on gender and ethnicity. Men appeared to benefit cognitively more from two-year college while women realized greater cognitive returns from four-year colleges. Non-white students benefited more from attendance at a two-year college while the reverse was true for their white counterparts.

Since its inception, the two-year community college has developed into one of the major institutional configurations in the American postsecondary educational system. There can be little doubt that, in an absolute sense, the existence of two-year institutions has substantially increased both the access to higher education as well as the social mobility of numerous individuals whose education would have previously ended with high school (Cohen & Brawer, 1982, 1989; Nunley & Breneman, 1988). However, a major critique of the two-year college posits that, while it may largely guarantee equality of opportunity for access to higher education, it has not, relative four-year colleges and universities, provided equal opportunity in terms of the outcomes or benefits of higher education (Astin, 1977; Brint & Karabel, 1989; Grubb, 1984; Karabel, 1986; Zwerling, 1976).

A modest, but growing body of research has sought to answer the question of the relative impacts of initial attendance at a two-year versus a four-year college or university. The preponderance of this inquiry has focused on the relative socioeconomic payoffs linked to initial enrollment in these different types of postsecondary institutions. The findings of this research with respect to educational attainment are reasonably clear. With controls made for important individual background differences, students who initially enroll in two-year colleges seeking a bachelor's degree are about 15% less likely to complete that degree in the same period of time as similar students who begin postsecondary education in four-year institutions (e.g., Alba

& Lavin, 1981; Astin, 1977; Crook & Lavin, 1989; Dougherty, 1987, 1992; Hilton & Schrader, 1986; Temple & Polk, 1986; Velez, 1985). The findings are more ambiguous with respect to actual labor-market outcomes. Although exceptions exist (e.g., Monk-Turner, 1988), the weight of evidence would suggest that, when individuals of equal educational attainment and background characteristics are compared, there is a general parity between those initially enrolling in two-year and four-year colleges in such areas as occupational status, earnings, job stability, unemployment rate, or job satisfaction (e.g., Anderson, 1984; Breneman & Nelson, 1981; Smart & Ethington, 1985; Whitaker & Pascarella, 1994).

Although we have learned much from the inquiry on socioeconomic outcomes conducted over the past decade, little research has directly addressed the relative intellectual or cognitive effects of attendance at two-year versus four-year colleges. It has been argued that we might expect two-year institutions to have a less powerful impact on the cognitive growth of students because such institutions admit students with lower levels of academic preparation and motivation than those admitted to four-year colleges. This can lead to the development of a normative peer culture that offers little support for intellectual or academic effort, paired with a faculty that has lower expectation and places less rigorous demands on student academic performance (e.g., Dougherty, 1987; London, 1978; Neuman & Reisman, 1980). Consistent with this argument there is at least modest evidence that two-year college students find it difficult to

Wattenbarger, 1985). While it is tempting to conclude that this reflects the less rigorous academic preparation in two-year colleges, such a finding could also simply reflect the normal problems inherent in becoming socially and academically integrated in a new institutional setting (Pascarella & Terenzini, 1991).

Research focusing directly on the relative cognitive effects of attendance at two-year and four-year colleges is almost nonexistent. The evidence that does exist, however, does not support the argument that students are less challenged intellectually at two-year institutions than they are at four-year colleges and universities. Bohr, et al. (1994) compared 35 students from a two-year college located near a large urban area and 169 students from a nearby research university on first-year gains in standardized measures of reading comprehension, mathematics, and critical thinking. Statistically controlling for precollege cognitive skills, age, work responsibilities, and full or part-time enrollment, two-year college students made 1991-92 academic year gains on all three cognitive measures that were equal in magnitude to those made by students at the four-year institution. We know of no other subsequent or prior work, however, that even attempts to replicate these findings (see, for example, Astin, 1993; Pascarella & Terenzini, 1991).

Clearly it is risky to draw from conclusions from a body of evidence consisting essentially of a single study, Bohr, et al. (1994), that is based on a small sample from only two institutions. The small sample (N = 204), with attendant limited statistical

power, means that the study ran at least some risk of a type II error (i.e., failing to identify statistically significant two-year/four-year cognitive differences when they actually existed). More serious, perhaps, is the fact that the sample was drawn from only one two-year and one four-year institution, both located in the same metropolitan area. This means that the evidence may also be quite limited in terms of generalizability. One might anticipate that the populations of two-year and four-year institutions would not be completely homogeneous in their educational impacts (e.g., Astin, 1993; Chickering & Reisser, 1993; Kuh, 1993). Consequently, it may be imprudent to assume that a single two-year and a single four-year institution adequately represent those respective populations.

The present study sought to contribute to a better understanding of the relative cognitive impacts of two- and four-year colleges by means of an investigation that was both longitudinal and multiinstitutional. Specifically, the study had two purposes. First, employing a matched sample of five two-year and six four-year colleges from nearly all geographical regions of the country, it sought to estimate the net impact of attending a two-year versus a four-year college on students' freshman-year development in reading comprehension, mathematics, critical thinking, and composite achievement. In doing so it employed instruments specifically designed to assess cognitive and intellectual skills acquired during the first two years of college. Second, the study attempted to determine the extent to which the

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cognitive effects of attending a two-year versus a four-year college differ in magnitude for students with different background and other characteristics.

Method

Institutional Sample

The sample was selected from incoming freshman students at 18 four-year and 5 two-year colleges and universities located in 16 different states throughout the country. Institutions were selected from the National Center on Education Statistics IPEDS data base to represent differences in colleges and universities nationwide on a variety of characteristics including institutional type and control (e.g., private and public research universities, private liberal arts colleges, public and private comprehensive universities, two-year colleges, historically black colleges), size, location, commuter versus residential, and the ethnic distribution of the undergraduate student body. In aggregate, the student population of those 23 schools approximated the national population of undergraduates by ethnicity and gender.

Student Sample and Instruments

The individuals in the overall sample were 2685 freshman-year students who participated in the National Study of Student Learning (NSSL), a large longitudinal investigation of the factors that influence learning and cognitive development in college. The research was sponsored by the federally-funded National Center on

Postsecondary Teaching, Learning, and Assessment. The initial sample was, as far as possible, selected randomly from the incoming freshman class at each participating institution. The students in the sample were informed that they would be participating in a national longitudinal study of student learning and that they would receive a stipend for their participation. They were also informed that the information they provided would be kept confidential and would never become part of their institutional record.

An initial data collection was conducted in the Fall of 1992. The data collection lasted approximately three hours and students were paid a stipend of $25 by the National Center on Postsecondary Teaching, Learning, and Assessment. Students were reminded that the information they provided would be kept in the strictest confidence an that all that was expected of them was that they give an honest effort on tests and a candid response to all questionnaire items. The data collected included a precollege survey that gathered information on student demographic characteristics and background, as well as aspirations, expectations of college, and a series of items assessing their orientations toward learning. Participants also completed Form 88A of the Collegiate Assessment of Academic Proficiency (CAAP). The CAAP was developed by the American College Testing Program (ACT) specifically to assess selected general skills typically acquired by students during the first two years of college (ACT, 1990). The total CAAP consists of five 40-minute, multiple-choice test modules, three of which--reading comprehension, mathematics, and

critical thinking--were administered during the first data collection.

The CAAP reading comprehension test is comprised of 36 items that assess reading comprehension as a product of skill in inferring, reasoning, and generalizing. The test consists of four prose passages of about 900 words in length that are designed to be representative of the level and kinds of writing commonly encountered in college curricula. The passages were drawn from topics in fiction, the humanities, the social sciences, and the natural sciences. The KR-20, internal consistency reliabilities for the reading comprehension test range between .84 and .86. The mathematics test consists of 35 items designed to measure a student's ability to solve mathematical problems encountered in many postsecondary curricula. The emphasis is on quantitative reasoning rather than formula memorization. The content areas tested include pre-, elementary, intermediate, and advanced algebra, coordinate geometry, trigonometry, and introductory calculus. The KR-20 reliability coefficients for the mathematics test ranged between .79 and .81. The critical thinking test is a 32-item instrument that measures the ability to clarify, analyze, evaluate, and extend arguments. The test consists of four passages that are designed to be representative of the kinds of issues commonly encountered in a postsecondary curriculum. A passage typically presents a series of subarguments that support a more general conclusion. Each passage presents one or more arguments and uses a variety of formats, including case studies, debates,

dialogues, overlapping positions, statistical arguments, experimental results, or editorials. Each passage is accompanied by a set of multiple choice items. The KR-20 reliability coefficients for the critical thinking test ranged from .81 to .82 (ACT, 1990). In pilot testing various instruments for use in the National Study of Student Learning on a sample of 30 college students the critical thinking test of the CAAP was found to correlate .75 with the total score on the Watson-Glaser Critical Thinking Appraisal.

Each of the 23 institutions was given a target sample size relative in magnitude to the respective sizes of the freshman class at each institution. The overall target sample for the Fall 1992 data collection at the 23 institutions was 5,000. The overall obtained sample size, (i.e., those students actually tested) for the Fall 1992 data collection was 3,840, or a response rate of 76.8%.

A follow-up testing of the sample took place in the Spring of 1993. This data collection required about 31/2 hours and included and extensive set of measures of the students' freshman-year experience and Form 88B of the CAAP reading comprehension, mathematics, and critical thinking modules. Students were paid a second stipend of $35 by the National Center on Postsecondary Teaching, Learning, and Assessment for their participation in the follow-up data collection. Of the original sample 3, 840 students who participated in the Fall, 1992 testing, 2,685 participated in the Spring, 1993 data collection, for a follow-up response rate of

69.92%.

Given the high response rates at both testings it is not particularly surprising that the sample was reasonably representative of the population from which it was drawn. However, to adjust for potential response bias by gender, ethnicity, and institution, a sample weighting algorithm was developed. Specifically, within each individual institution participants in the follow-up data collection were weighted up to the institution's freshman population by gender (male or female) and ethnicity (white, black, hispanic, other). Thus, for example if institution A had 100 black men in its freshman class and 25 black men in the sample, each black male in the sample was given a sample weight of 4.00. An analogous weight was computed for participants falling within each gender x ethnicity cell within each institution. The effect of applying sample weights in this manner was to adjust not only for response bias by gender and ethnicity, but also for response bias (i.e., differential response rates) by institution.

Final Matched Sample

Because of the broad diversity of institutions in the overall sample, comparing two-year colleges with all four-year colleges seemed unrealistic. For example, the four-year college sample contained a private university and a private liberal arts college that were among the most academically selective in the country, and enrolled almost totally residential student bodies. Similarly, the

four-year college sample also contained two historically black colleges that enrolled almost no non-black students. Consequently, rather than using a comparison group of all 18 four-year institutions we selected a matched group of six four-year institutions whose incoming student bodies closely resembled those of the five two-year colleges in academic preparation. The matching was based on a composite scale consisting of the three fall, 1992 precollege scores on the CAAP reading comprehension, mathematics and critical thinking tests. The five two-year colleges were located in five different states throughout the country (New England, the Carolinas, the Midwest, the Mountain States, and the Pacific Coast). Similarly, the six matching four-year colleges were also distributed throughout the same parts of the country in six different states. The four-year sample contained a liberal arts college, urban commuter institutions, comprehensive universities and a research university. The final sample on which all analyses were conducted consisted of 811 students, 280 attending the five two-year colleges and 531 attending the six four-year institutions.

Design and Data Analysis

The study design was a pretest-posttest quasi-experimental design, in which comparison groups were statistically equated on salient precollege (Fall, 1992) and other variables. The comparison groups were students attending the five two-year colleges and students attending the matched sample of six four-year

colleges and universities. The dependent variables were Spring 1993 scores on the CAAP reading comprehension, mathematics, and critical thinking tests, plus a measure of freshman year composite achievement that combined all three tests. The composite achievement measure was constructed in two steps. First each of the three CAAP tests (i.e., reading, math, and critical thinking) was standardized to put each on the same metric. Subsequently the composite achievement score was computed by summing across standardized scores and assigning an arbitrary scale mean of 0 and standard deviation of 1 for the entire follow-up sample (N=2685). The alpha, internal consistency, reliability for the composite achievement measure was .83.

In order to statistically control for precollege and other salient differences between students attending two-year and four-year institutions least-squares analysis of covariance was the basic analytic approach. Individuals were the unit of analysis. Guided by the existing body of evidence on the factors independently influencing learning and cognitive development during college (e.g., Astin, 1968, 1977, 1993; Astin & Panos, 1969; Kuh, 1993; Pascarella & Terenzini, 1991), the individual level covariates in the study were the following:

1. Individual Fall, 1992 (precollege) CAAP reading comprehension, mathematics, critical thinking, and composite achievement scores [each employed in analysis of the appropriate end-of-freshman year (Spring, 1993) CAAP reading comprehension, mathematics, critical thinking, and composite achievement score].

2. Gender

3. Ethnicity: white or non-white.

4. Family social origin: the combination of standardized measures of mother's and father's level of formal education and combined family income.

5. Fall, 1992 (precollege) academic motivation: an eight-item, Likert-type scale (4 = strongly agree to 1 = strongly disagree) with an internal consistency reliability of .65. The scale items were developed specifically for the NSSL, and were based on existing research on academic motivation (e.g., Ball, 1977). Examples of constituent items are: "I am willing to work hard in a course to learn the material, even if it won't lead to a higher grade," "When I do well on a test it is usually because I was well prepared, not because the test was easy," "In high school I frequently did more reading in a class than was required simply because it interested me," and "In high school I frequently talked to my teachers outside of class about ideas presented during class."

6. Age: age in years in Fall, 1992.

7. Credit hours taken: total number of credit hours for which the student was enrolled during the freshman year.

8. Work responsibilities: Average number of hours worked, on- or off-campus, during the freshman year.

9. On- or off-campus residence: a dichotomous variable indicating whether the student resided on-campus or lived off-campus and commuted to college during the freshman year.

Because the existing body of evidence suggests that institutional context can often shape the impact of college in indirect, if not direct, ways, we also included one institutional-level variable as a covariate in the analytic model. This was:

10. The level of academic aptitude of the freshman class: estimated by the average Fall, 1992 CAAP reading, mathematics, critical thinking, or composite achievement score for the freshman class at each of the 11 institutions. Each student in the sample was given the mean of his or her institution on all three CAAP test plus the composite, and each of the institutional mean scores was employed in analysis of the appropriate end-of-freshman year (Spring, 1993) individual-level reading comprehension, mathematics, critical thinking, or composite achievement score.

The analysis of covariance for each of the four dependent measures employed a least-squares regression solution, and was conducted in a hierarchical manner. The influence of attending a two-year versus a four-year institution was estimated while controlling for the effects of all ten covariates. The results of this analysis provided estimates of the effects of two- versus four-year college attendance on end-of-freshman year reading comprehension, mathematics, critical thinking, and composite achievement, net of the influence of the covariates. Since precollege (Fall, 1992) reading, mathematics, critical thinking, and their composite were included among the covariates, a significant effect attributable to attending a two-year versus a four-year college permits one to conclude that there are

significant net differences between students attending two- and four-year colleges, not only in end-of-freshman year reading comprehension, mathematics, critical thinking, and composite achievement but also in the gains made on those cognitive dimensions during the freshman year (Linn, 1986; Linn & Slinde, 1977; Pascarella & Terenzini, 1991).

In the second stage of the analyses we tested for the presence of covariate x two- versus four-year college conditional effects, one of the assumptions of the analysis of covariance model (Elashoff, 1969; Kerlinger & Pedhazur, 1973). A series of cross-product terms was computed between two- versus four-year college attendance and each of the ten covariates. These were then added to the regression model containing the covariates and a dummy variable representing attendance at a two-year versus or four-year institution (i.e., the main-effects model). A statistically significant increase in the explained variance (R^2) attributable to the set of cross-product terms (over and above the main-effects model) indicates that the net effects of attending a two -versus a four-year college vary in magnitude for individuals at different levels of the respective covariates.

The weighted sample, adjusted to the actual (unweighted) sample size to obtain correct standard errors, was used in all analyses. Although a set of supplementary unweighted analyses yielded results essentially the same as those with the weighted sample, we report weighted sample estimates in the remainder of the paper.

RESULTS

Table 1 shows the analysis of covariance summaries, and Table 2 reports the weighted covariate-adjusted means and standard deviations on all four cognitive outcomes for students attending two-year and four-year institutions. As shown in Table 1, when the influence of all ten covariates was controlled there were no statistically significant differences between two- and four-year college students on any of the four end-of-freshman year cognitive outcomes. As previously indicated in the methods section, this is essentially the same as saying that there were no significant two-year/four-year college differences in the freshman-year gains made in reading comprehension, mathematics, critical thinking, or composite achievement. Only one analysis approached statistical significance. On mathematics the null hypothesis for the two-year versus four-year college difference could be rejected at $p < .10$.

Place Tables 1 & 2 About Here

As shown by the covariate-adjusted means in Table 2, there was no clear group trend in the non-significant results. Four-year college students had slightly higher end-of-freshman year reading comprehension and critical thinking scores, while two-year college students had higher end-of-freshman year mathematics and composite achievement.

The second stage of the analyses sought to determine if the cognitive effects of attending a two-year versus a four-year

college are general or conditional. The addition of the set of cross-product terms to the main-effects model was associated with small (i.e., 1.2 - 2.2%) but statistically significant increases in explained variance for all four cognitive outcomes. This suggested the presence of statistically significant covariate x two- versus four-year college conditional effects. To determine the nature of these conditional effects each of the four freshman-year cognitive outcomes was regressed on the 10 covariates separately for the two-year and the four-year college samples. T-tests for the significance of a difference in regression coefficients between independent samples were then used to determine which conditional effects were statistically significant (Cohen & Cohen, 1975).

In all cases the significant conditional effects involved student race or gender. That is, the cognitive effects of attending a two- versus a four-year college differed in magnitude for women versus men and for non-white versus white students. Table 3 shows the respective partial metric regression coefficients that were significantly different ($p < .05$) between women (coded 1) and men (coded 0), or between non-white students (coded 1) and white students (coded 0). In all cases the regression coefficients shown are with the influence of all other covariates in the model controlled statistically.

Place Table 3 About Here

In the gender conditional effects women appeared to benefit

more in first-year reading, critical thinking, and composite achievement from attending a four-year college than their male counterparts. Conversely, men appeared to benefit somewhat more on those same three dimensions from attending a two-year college. In the conditional effects involving ethnicity non-white students appeared to derive the greatest cognitive benefits in reading, mathematics, and critical thinking from first-year attendance at a two-year college. For their white counterparts, however, the reverse was true. White students appeared to benefit more on those same three dimensions from attendance at a four-year college.

SUMMARY AND CONCLUSIONS

Contrary to many prevailing notions about the academic rigor of two-year college programs, and replicating previous findings, the evidence from this longitudinal investigation further suggests the possibility of a general parity in the relative cognitive impacts of two- and four-year colleges. Previous research, employing small student samples drawn from one two- and one four-year college, found only trivial differences in the relative first-year gains in reading comprehension, mathematics, and critical thinking made by these two respective student groups (Bohr, et al., 1994). The present study employed a multiinstitutional sample of students from five two-year and six matched four-year colleges located throughout the country. (All eleven institutions were different than those studied by Bohr, et al.) With controls made for precollege cognitive skills, precollege academic motivation,

age, gender, ethnicity, family social origins, credit hours taken, work responsibilities, place of residence, and the average student body academic aptitude of the institution attended, no significant differences were found between two- and four-year college students in end-of-freshman year reading comprehension, mathematics, critical thinking, or a composite measure of all three tests. This is the equivalent of saying that there were no significant differences between the two- and four-year college samples in the freshman-year gains made on the four cognitive measures.[1] Furthermore, there was no clear general trend in the nonsignificant differences in end-of-freshman year scores (or freshman-year gains) favoring either the two-year or the four-year sample. The two-year college sample had slightly higher end-of-freshman year scores (or gains) in mathematics and composite achievement, while the four-year sample had slight advantages in reading comprehension and critical thinking.

The findings of this study are also consistent with a growing body of evidence suggesting that, when educational attainment and background are controlled, students initially attending two-year colleges can compete on equal terms with their four-year college counterparts in such areas as occupational status, earnings, job stability, and job satisfaction. In their national study of the occupational and economic consequences of where one begins postsecondary education Whitaker and Pascarella (1994) conclude that, when one considers its relatively lower tuition costs, the two-year college represents a cost-effective way of obtaining the

first two-years of college without sacrificing job market competitiveness. The present findings would suggest further that the relatively lower tuition costs of attending a two-year (versus a four-year) college do not necessarily come at the price of a less intellectually rigorous academic program.

A second major question of this study concerned whether or not the cognitive effects of attending a two- versus a four-year college differed for different kinds of students. The findings of analyses addressing this question suggest that the overall parity in cognitive effects associated with two- versus four-year college attendance, while significant in its own right, may mask the presence of differential effects based on gender and ethnicity. Irrespective of ethnicity and other characteristics, women appear to derive greater cognitive benefits than men from four-year college attendance, while men appear to derive somewhat greater cognitive benefits than women from two-year college attendance. Similarly, irrespective of gender and other characteristics, non-white students appear to receive greater cognitive benefits than their white counterparts from first-year attendance at a two-year college. Conversely, white students appear to derive relatively greater cognitive benefits from four-year college attendance than do non-white students.

It is important to point out that conditional effects in non-experimental research on college impacts do not replicate particularly well (Pascarella & Terenzini, 1991). Consequently, it is probably prudent to regard the gender- and ethnicity- based

conditional effects uncovered in this study as preliminary and suggestive rather than confirmatory or conclusive. They await replication, but they also underscore the importance of investigating the presence of conditional effects in studies that examine the relative impacts of different kinds of postsecondary institutions. Failure to do so could, as the findings of this study suggest, mask the presence of significant institutional impacts for different subgroups of students.

LIMITATIONS

This investigation has several limitations that should kept in mind when interpreting the findings. First, although the overall sample is multiinstitutional and consists of a broad range of two- and four-year institutions from around the country, the fact that the analyses were limited to a matched sample of 5 two-year and 6 four-year colleges means that we cannot necessarily generalize the results to all two- and four-year institutions. Similarly, although attempts were made in the initial sampling design and subsequent sample weighting to make the sample as representative as possible at each institution, the time commitment and work required of each student participant undoubtedly led to some self-selection. We cannot be sure that those who were willing to participate in the study responded in the same way as would those who were invited but declined to participate in the study. Weighed against this, however, is the fact we found no significant conditional effects involving such factors as age, family socioeconomic status,

precollege academic aptitude, credit hours taken, or work responsibilities. Thus, even if the sample had some bias on these factors it did not appear to have an appreciable influence on the study results. Third, while we looked at several different measures of cognitive development in college (reading comprehension, mathematics and critical thinking), these are certainly not the only dimensions along which students develop intellectually during the college years. Alternative conceptualizations or approaches to the assessment of cognitive development might have produced findings different from those yielded by this investigation. Finally, this study is limited by the fact that it was only able to trace cognitive growth over the first year of college. We cannot be sure that the apparent overall parity in freshman-year cognitive growth demonstrated by two-year and four-year college students would persist over the next year of college.

Footnotes

1. It is sometimes risky to apply a substantive interpretation to non-significant differences because they can be caused by statistical and measurement artifacts. However, those particular artifactual conditions are unlikely to hold in the present study for four reasons. First, the unweighted (actual) sample size of 811 is sufficiently large to detect rather small between-group effects (Cohen & Cohen, 1975). Second, each of the four dependent measures had more than adequate reliability (.80 or higher) to detect between-group differences (Thorndike & Hagen, 1977). Third, the use of strong covariates, including a parallel precollege measure of each dependent variable, substantially lowered the error term and dramatically increased the probability of finding any real between-group differences that existed (Pedhazur, 1982). Finally, the dependent measures employed in the study each tap cognitive dimensions shown to be significantly influenced by exposure to postsecondary education (Pascarella & Terenzini, 1991).

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TABLE 1

ANALYSIS OF COVARIANCE SUMMARIES OF THE EFFECTS OF ATTENDING A TWO-YEAR VERSUS A FOUR-YEAR INSTITUTION ON END-OF-FRESHMAN YEAR READING COMPREHENSION, MATHEMATICS, CRITICAL THINKING, AND COMPOSITE ACHIEVEMENT

Source	Reading Comprehension		Mathematics		Critical Thinking		Composite Achievement	
	df	F	df	F	df	F	df	F
Covariates*	10	80.06*	10	123.04*	10	142.54*	10	229.68*
Attended a Two-Year Versus a Four-Year Institution	1	1.83	1	2.68	1	.30	1	.39
Residual	799		799		799		799	
Total	810		810		810		810	

*Individual Fall, 1992 reading, math, critical thinking, or composite achievement score; Average Fall, 1992 reading, math, critical thinking, or composite achievement score for each institution; Gender; Ethnicity; Age; Family social origins; Fall, 1992 academic motivation; Freshman year credit hours taken; Work responsibilities; On- or off-campus residence.

*$p < .01$